

## NEW NODULATING LEGUME SPECIES FROM NATURAL ECOSYSTEMS OF PAKISTAN

Mohammad Athar

Pakistan Agricultural Research Council, P. Box 1031, Islamabad, PAKISTAN

### ABSTRACT

Nodulation is reported for the first time in two Mimosoid species belonging to tribe Mimosae and eight Papilionoid species distributed in tribes Galegeae, Phaseoleae, Robinieae, and Trifolieae. Abundant nodulation under natural conditions indicates distribution of a wide range of naturalized rhizobia in the soil. Evaluation of these naturalized rhizobia would be of great agronomic and economic value for the selection of effective legume-*Rhizobium* combinations useful in agrosystems.

KEY WORDS: Nodulation, Leguminosae, taxonomy, Pakistan

### INTRODUCTION

The improvement of soils is prerequisite for enhancing the productivity and restoring ecological equilibrium in agricultural and degraded forest ecosystems, respectively. Nodulated legumes have great potential for increasing or restoring soil fertility. The global records of nodulation compiled by Allen & Allen (1981) show that only 15% of legume species have been screened for nodulation. Since the classic work of Allen & Allen (1981) more legumes have been observed for nodulation and percentage of legume species examined has risen to 20% (Faria, *et al.* 1994). Despite many efforts (Wester & Hogberg 1989; Athar & Mahmood 1985, 1990; Mahmood & Iqbal 1994; Faria, *et al.* 1994; Aguilar, *et al.* 1994; Subramaniam & Babu 1994), there is a lack of information on the nodulating status of many tropical legumes.

Legumes are well distributed in Pakistan, and Leguminosae ranks as the third largest family in order of abundance. Ali & Qaiser (1986) mentioned 107 legume genera from Pakistan, of which 68 genera have one or more native species. A total of 539 legume species are reported to occur in Pakistan, of which 426 are native (Kirkbride 1986). However, the number of legumes found in Pakistan has changed during the last decade with the introduction of numerous exotic species in agriculture and forestry.

Athar & Mahmood (1985, 1990), Athar (1993), and Mahmood & Iqbal (1994) have contributed substantially to knowledge of the nodulating status of legumes of Pakistan. The present paper reports ten nodulated legume species for the first time from natural ecosystems of Pakistan.

## MATERIALS AND METHODS

The legumes growing under field conditions were examined for their nodulating ability as described previously (Athar & Mahmood 1985, 1990). Wild legumes were examined in their natural habitats while the introduced legumes were studied in the field trials of Pakistan Agricultural Research Council and provincial forest departments. Nodulation data were recorded and herbarium specimens were prepared for the identification of the plants. The nomenclature and tribal classification are as described by Kirkbride (1986). Author citations are quoted following instructions of Brummit & Powell (1992). Nodules were distinguished from other kinds of pathogenic root-malformation and many stubby root out-growths (including ectomycorrhizae) which could be misidentified as nodules (Truchet, *et al.* 1989).

## RESULTS AND DISCUSSION

According to compilation of reports on nodulation (Allen & Allen 1981; Athar & Mahmood 1980, 1985, 1990; Corby 1988; Wester & Hogberg 1989; Moreira, *et al.* 1992; Aguilar, *et al.* 1994; Faria, *et al.* 1994; Mahmood & Iqbal 1994; Athar 1996), nodulation is reported for the first time in two species of Mimosoideae and eight species of Papilionoideae (Table 1).

Nodules in these taxa were mainly distributed on the crown region of the primary root. Nodule morphology in Papilionoideae and Mimosoideae coincided very much with the description of Corby (1988) and Mahmood & Iqbal (1994). Nodules in Papilionoideae were generally semi-globose to globose with streaked or smoothed surface. They occurred singly or as lobed structures. Nodules in Mimosoideae were elongated and branched projecting into finger-like, fan-shaped, or coralloid forms. Nodules were mostly pink or brown with reddish interior. The crown nodulation coupled with abundant leghaemoglobin indicates the effectiveness of these nodules.

Majority of these species were abundantly nodulated under natural ecosystems (Table 1), indicating distribution of a wide range of naturalized rhizobia in Pakistani soil. However, tropical rhizobial populations are known to exhibit genetic heterogeneity as well as high host specificity. Consequently, adaptive radiation in legume-*Rhizobium* symbiosis has taken place in terms of number and kinds of legume-*Rhizobium* associations (Subramaniam & Babu 1994). Evaluation of these associations is of great agronomic and economic value for the selection of effective legume-*Rhizobium* combinations useful in agrosystems.

Table 1. List of new nodulated legume species.

Species	Legume status <sup>1</sup>	Nodulation frequency <sup>2</sup>
<b>MIMOSOIDEAE</b>		
<b>Mimoseae</b>		
<i>Leucaena diversifolia</i> Benth.	I	+++
<i>L. pulverulenta</i> (Schltdl.) Benth.	I	+++
<b>PAPILIONOIDEAE</b>		
<b>Galegeae</b>		
<i>Astragalus glycyphyllos</i> L.	W	+
<i>Colutea nepalensis</i> Sim.	W	+
<b>Phaseoleae</b>		
<i>Mucuna nigricans</i> (Lour.) Steud.	W	++
<b>Robinieae</b>		
<i>Sesbania formosa</i> Benth.	I	+++
<b>Trifolieae</b>		
<i>Medicago globosa</i> Presl.	I	+++
<i>M. reticulata</i> Benth.	I	++
<i>M. rotata</i> Bois.	I	++
<i>M. tribuloides</i> Desr.	I	+++

<sup>1</sup>Legume status:

W = Wild; I = Introduced in Pakistan.

<sup>2</sup>Nodulation frequency:

+, indicates sparse nodulation (1 to 5 nodules per plant).

++, indicates moderate nodulation (6 to 10 nodules per plant).

+++, indicates abundant nodulation (more than 15 nodules per plant).

#### ACKNOWLEDGMENTS

Thanks are due to Dr. Jim Harding, Dr. Ellen Dean, and Dr. Grady Webster and the staff at J.M. Tucker Herbarium for helpful discussion and for the nomenclature of the plants. Appreciations are extended to Dr. S.M. de Faria, Dr. Janet I. Sprent, and Dr. A. Mahmood for their cooperation in checking nodulated legumes against their records.

## LITERATURE CITED

- Aguilar, N.O., F.C. Pitargue, & M.O. Cajano. 1994. Nodulation of legumes in the Philippines. In: J.I. Sprent & D. McKey (eds.), *Advances in Legume Systematics 5: The Nitrogen Factor*, pp. 25-31. Royal Botanic Gardens, Kew, Great Britain.
- Ali, S.I. & M. Qaiser. 1986. A phytogeographical analysis of the Phanerogams of Pakistan and Kashmir. Proc. Royal Soc. Edinburgh 89B:89-101.
- Allen, O.N. & E.K. Allen. 1981. *The Leguminosae*. A source book of characteristics, uses and nodulation. University of Wisconsin Press, Madison, Wisconsin.
- Athar, M. 1993. Nodulation status of some tree legumes of Pakistan. Nit. Fix. Tree Res. Reports 11:32-34.
- Athar, M. 1996. Observations on nodulation status of some Papilionoid legumes of potential agricultural and forestry value from Sacramento Valley, California. Taiwania 41:296-303.
- Athar, M. & A. Mahmood. 1985. A qualitative study of the nodulating ability of legumes of Pakistan. List 3. Trop. Agric. (Trinidad). 62:49-51.
- Athar, M. & A. Mahmood. 1990. A qualitative study of the nodulating ability of legumes of Pakistan. List 4. Trop. Agric. (Trinidad). 67:53-56.
- Brummit, R.K. & C.E. Powell. (eds.). 1992. *Authors of Plant Names*. Royal Botanical Gardens, Kew, Great Britain.
- Corby, H.D.L. 1988. Types of rhizobial nodules and their distribution among the Leguminosae. Kirkia 13:53-124.
- Faria, S.M. de, H.C. de Lima, A.M. Carvalho, V.F. Concalves, & J.I. Sprent. 1994. Occurrence of nodulation in legume species from Bahia, Minas Gerais and Espirito Santo states of Brazil. In: J.I. Sprent & D. McKey (eds.), *Advances in Legume Systematics 5: The Nitrogen Factor*, pp. 17-23. Royal Botanic Gardens, Kew, Great Britain.
- Kirkbride, J.H. 1986. Phylogeny and classification of Pakistani legumes. Pak. J. Bot. 18:287-299.
- Mahmood, A. & P. Iqbal. 1994. Nodulation status of leguminous plants in Sindh. Pak. J. Bot. 26:7-19.
- Moreira, F.M. de Souza., M.F. da Silva, & S.M. de Faria. 1992. Occurrence of nodulation in legume species in the Amazon region of Brazil. New Phytol. 121:563-570.
- Subramaniam, B. & C.R. Babu. 1994. New nodulating legumes of potential agricultural and forestry value from subtropical Himalayan ecosystem. Biol. Agric. Hort. 10:297-302.
- Truchet, G., S. Camut, F. de Billy, F.R. Odorio, & J. Vasse. 1989. The *Rhizobium*-legume symbiosis: Two methods of discriminating between nodules and other root-derived structures. Protoplasma 149:82-88.
- Wester, J. & P. Hogberg. 1989. New nodulating legume tree species from Guinea-Bissau, West Africa. Forest Ecol. Manage. 29:311-314.